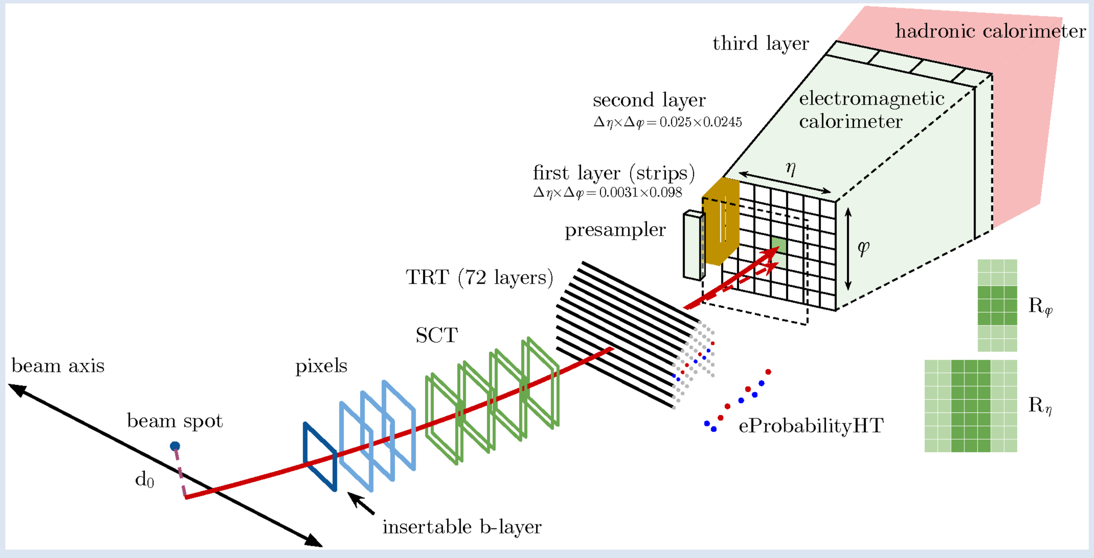
Measurements of electron identification efficiencies with the 2015 & 2016 pp-collision data in ATLAS at $\sqrt{s}$=13 TeV

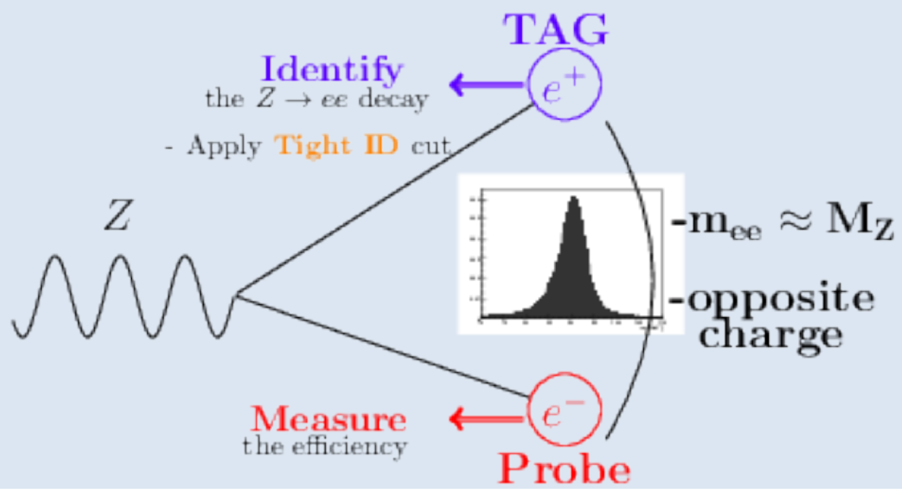
The results presented are from ATL-CONF-2016-024 (https://cds.cern.ch/record/2157687):
The ATLAS collaboration, "Electron efficiency measurement with the ATLAS detector using the 2015 LHC proton collision data", June 2016

Objective

- Prompt electrons are identified by a **cluster** in the electromagnetic calorimeter matched to a **track** in the **inner detector**
- Identification via **three identification (ID) criteria:** loose, medium, tight, defined via **Likelihoods** based on **calorimetric cluster shower shapes, track** and **track-to-cluster matching** variables
- The **tighter the ID criteria**, the **higher the rejection** of hadronic jets, electrons from photon conversion, Dalitz decays and from semileptonic heavy-flavour hadron decays but the **lower the identification efficiency**
- Measure identification efficiency in **data and MC**
- Measurements provided in bins of the **electron transverse momentum** and the **detector region** (pseudorapidity)



The Tag and Probe method



- Total efficiency to measure an electron in the ATLAS detector:

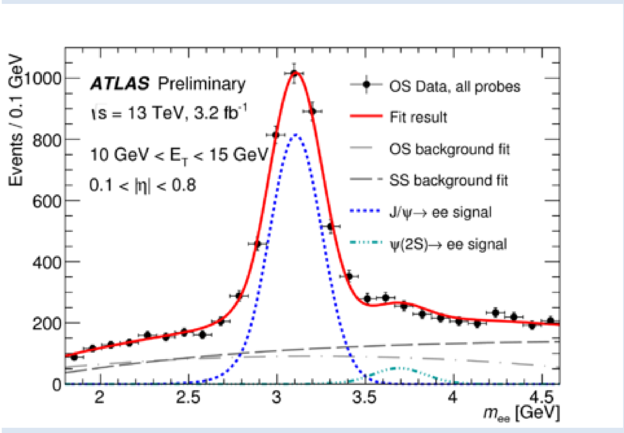
$$\varepsilon_{total}=\varepsilon_{Reco}*\varepsilon_{ID}*\varepsilon_{Iso}*\varepsilon_{Trigger}$$

- Measure **electron identification efficiency with respect to reconstructed electrons:**

$$\varepsilon_{ID}=\frac{N_{reconstructed\,,\,passID}}{N_{reconstructed}}$$

- **Background** in this measurement are objects misidentified as electrons (jets, photons), random combination of two electrons
- Use **Z→ee or J/ψ decay signature** to select a **sample of unbiased electrons** with **high purity**

Tag and Probe electron identification efficiency measurements for different electron energy ranges



J/ψ→ee

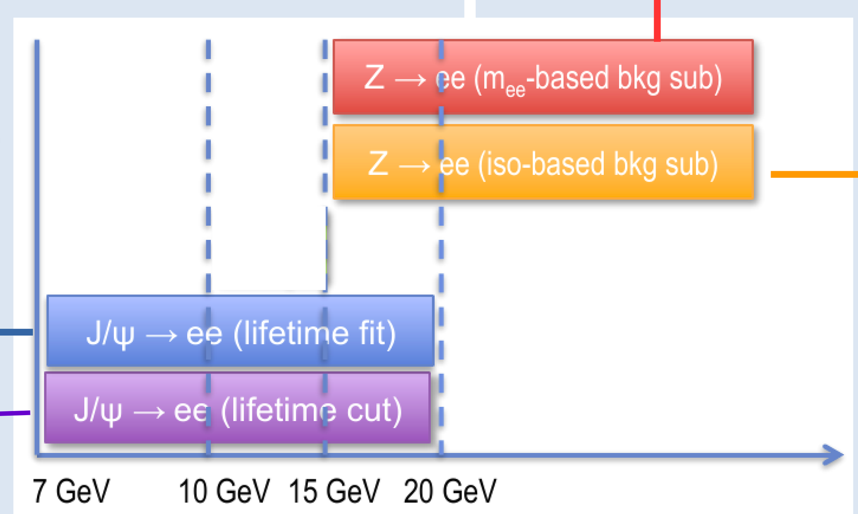
- **Tag and probe di-electron invariant mass** as **discriminating variable** between signal and background
  - **Analytic fit**, signal described using a Crystal Ball function, polynomials used for the background

J/ψ→ee decay topology

J/ψ events can originate from **prompt production** or **non-prompt production** (B-Hadron decay)
Only **prompt** production is of interest, since it is **closest to prompt electron production** from other **processes of interest** (e.g. Higgs decay)

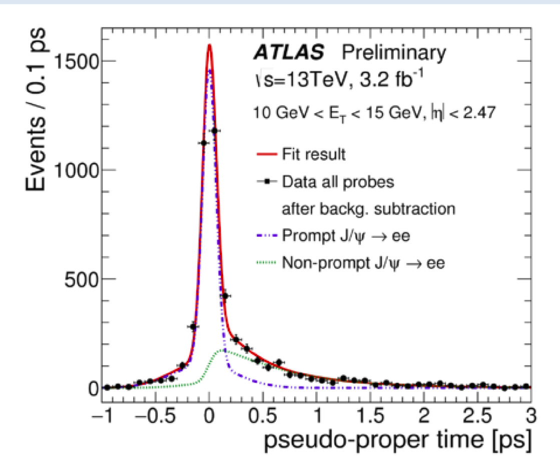
Two methods (τ-fit and τ-cut) to **separate prompt** and **non-prompt** components:
Use **pseudo-proper lifetime**
(L: distance between primary vertex and J/ψ vertex, $p_T^{J/\psi}$: J/ψ p_T)

$$\tau=\frac{L*m_{PDG}^{J/\psi}}{p_T^{J/\psi}}$$



τ-Fit

- Prompt and non-prompt component **distinguished by fitting** the **τ distribution**
- Measure **data ID efficiency** using **prompt** J/ψ decays



All probes

τ-Cut

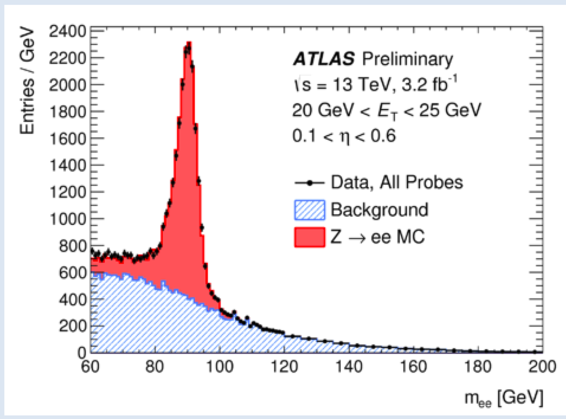
- Consider only events with a short lifetime: **Cut at τ < 0.2ps** to **eliminate** most **non-prompt J/ψ**

Z→ee

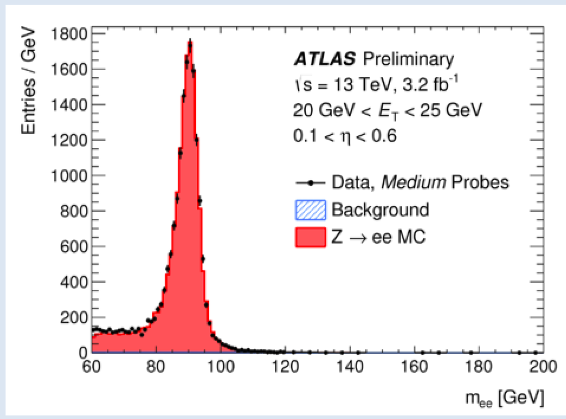
- Use **two methods** to **discriminate signal from background: Zmass & ZIso**
- Create **background model from data representing shape** of the discriminating variable **fake electron distribution** by requiring **objects to fail selected cuts**
- **Normalize background** model to data in **background-dominated region**

Zmass

- Use **Tag & Probe invariant mass** as discriminating variable
- Use **high invariant mass tail** to get the **normalization** of the **background model**



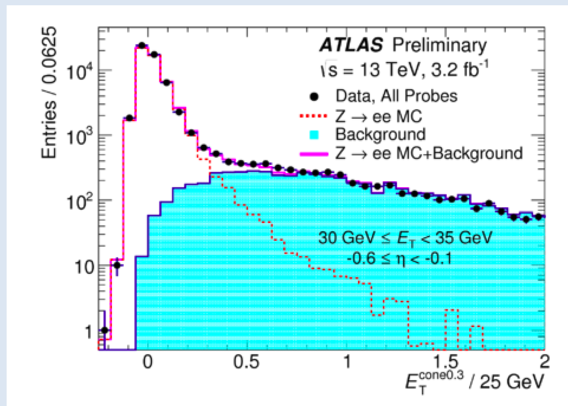
All probes



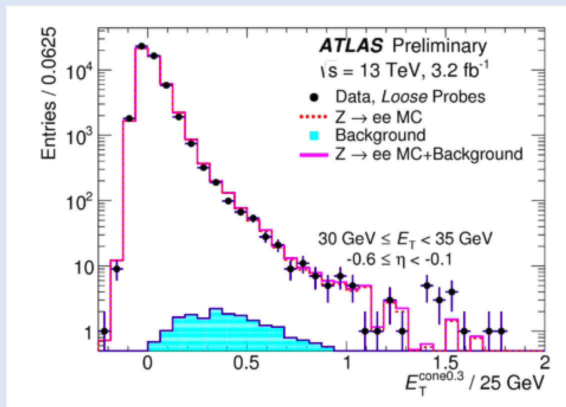
Medium probes

Ziso

- Use **probe isolation distribution** as discriminating variable
- Use **tail of the probe isolation distribution** to get the **normalization** of the **background model**



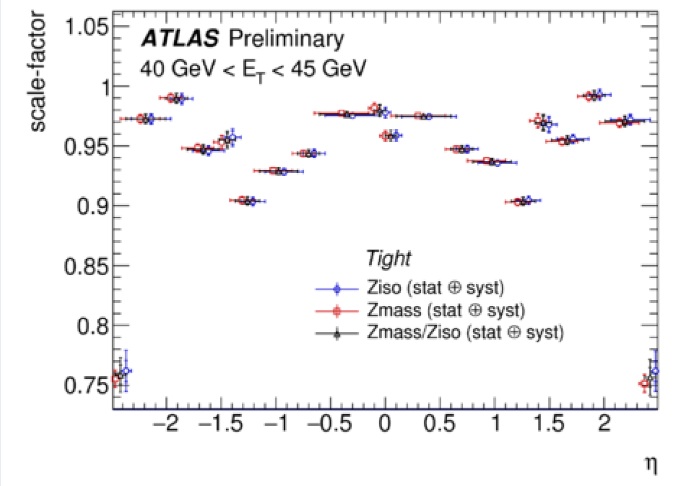
All probes



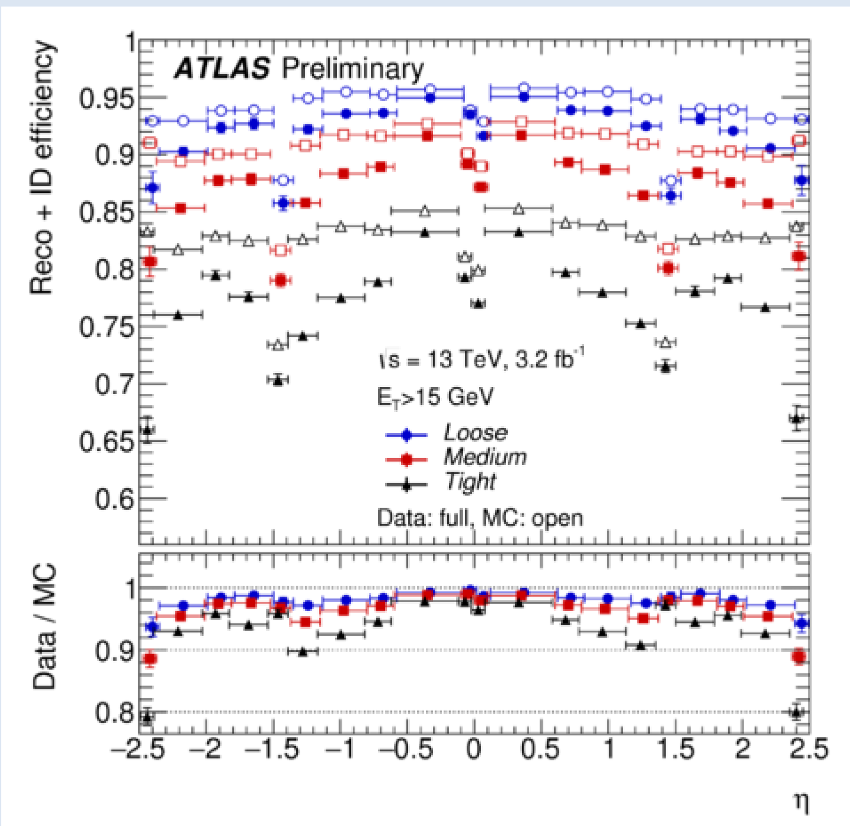
Loose probes

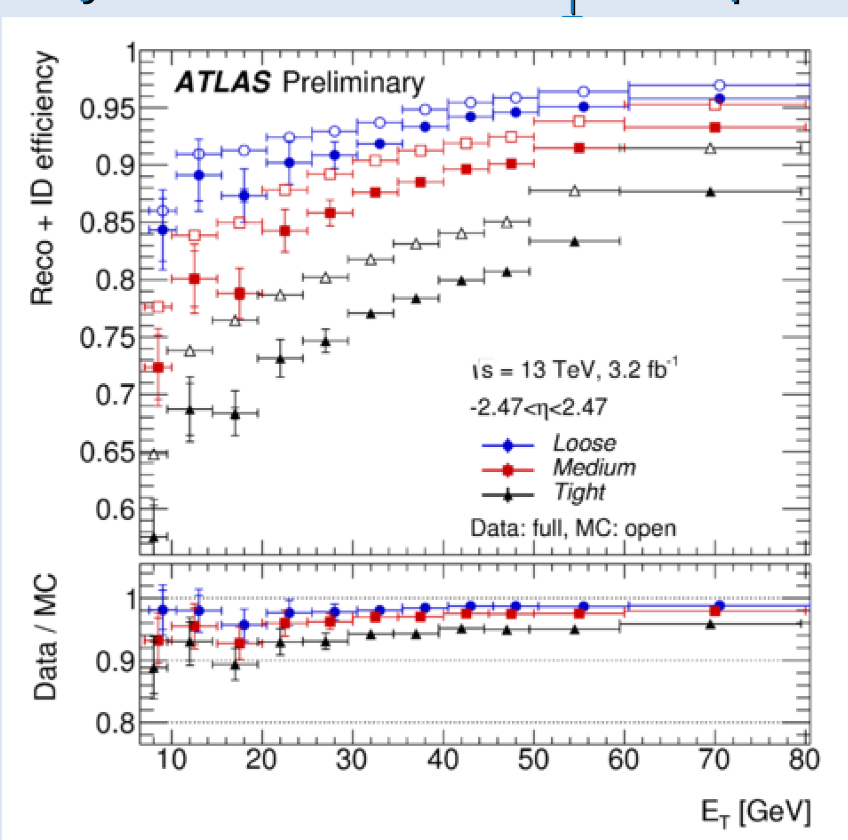
Evaluation of the uncertainties & Combination of results:

- **Systematic uncertainties** assigned for **background estimation,** bias from kinematic selection (Zmass/Ziso), tag/**probe isolation,** fit models and pseudo-proper time range (J/ψ), differences between Zmass/Ziso (τ-Cut/τ-Fit) methods
- **All methods are in good agreement**

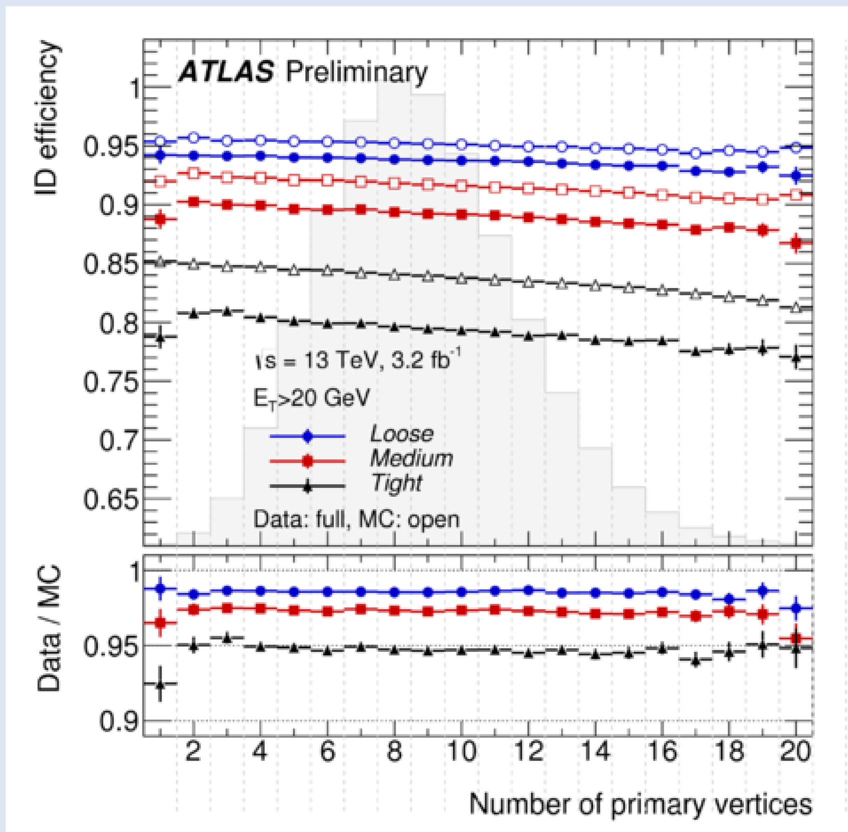


Results: Data and MC electron ID efficiency as a function of E_T and η:





ID efficiencies as a function of the number of vertices:



- **Typical identification efficiencies for electrons with E_T = 40 GeV range from 75% to 95% depending on the tightness of the ID criteria**
- **Measurement precision: 3-15% for very low electron E_T, 0.5-2.5% for medium E_T and 0.5-1% for high E_T**
- **Identification criteria stable in high pile-up environments**
- **The data/MC efficiency ratio ($\varepsilon_{Data}/\varepsilon_{MC}$) is used to obtain the identification efficiency in any process of interest, used to correct MC efficiencies to data**
- **These results have been used for all ATLAS measurements at 13 TeV with electrons up to now**

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LHCC Poster Session, 22.02.2017 CERN